Status Report on Implementation and Use of Collaboration Technology

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Summary

During this past year, a community-based effort to improve collaboration technology infrastructure within the fusion science program was funded by OFES. Three separate areas were addressed:

- Information technology to broadly support collaborations within the fusion program,
- Remote access to the large experiments (DIII-D, Alcator C-mod and NSTX)
- Software infrastructure to advance collaborations.

On the basis of a series of several rather intense conference calls, funding was made available late last fiscal year to address these issues on a priority basis. Progress on all fronts was made with systems now being installed and put to use. We have not surveyed all the collaboration sites as to the amount of use nor acceptance of the technology. The following report represents an initial survey as to the progress made at major sites in a relatively short period of time. One general conclusion is that the investment made by DoE in this collaboration technology has in a very short period of time made a positive impact on our ability to collaborate remotely.

Broad base support for collaborations.

The ability to more efficiently conduct business with a geographically dispersed work force is becoming an important issue for the work paradigm of today. Recognizing that scientists and engineers engaged in fusion research are widely spread over several laboratories and universities and that many work on more than one experiment, it was decided that technologies supporting collaborative efforts could play an important role in enabling and increasing the efficiency of our research efforts. The two main technologies considered were commercial video conferencing systems and the ability to interactively share presentation materials, e.g. “viewgraphs or transparencies”. In addition, techniques to better reach small groups or single researchers who may not have access to video conferencing were included.

To enable capability for remote viewing of presentations, a volume purchase of technology to allow simultaneous presentation of viewgraphs was completed. Twenty-one (in addition to the one already at LLNL) ShowStationIP units (from Polycom, www.polycom.com) were purchased at a sizeable reduction in cost and distributed throughout the community using a “priority list” based on the number of existing collaborations. The sites included in this bulk purchase are shown in figure 1. Alternatives such as “scanning to files” or requiring the use of pdf-format files were discussed, but only the ShowStationIP came close to preserving the style and flexibility of local presentation across the wide area network. This technology provides joint viewing of presentations among ShowStationIPs by simultaneously projecting transparencies in multiple conference rooms connected over wide area network (e.g. ESnet). Also, these systems are web servers and presentations can be simultaneously sent to browsers on the desktop. It supports presentations from remote locations from either a connected ShowStationIP or from a web browser. This is all done interactively during a presentation. The ShowStationIP thus affords the opportunity of preserving the spontaneous and interactive style of presentation commonplace in our research community.

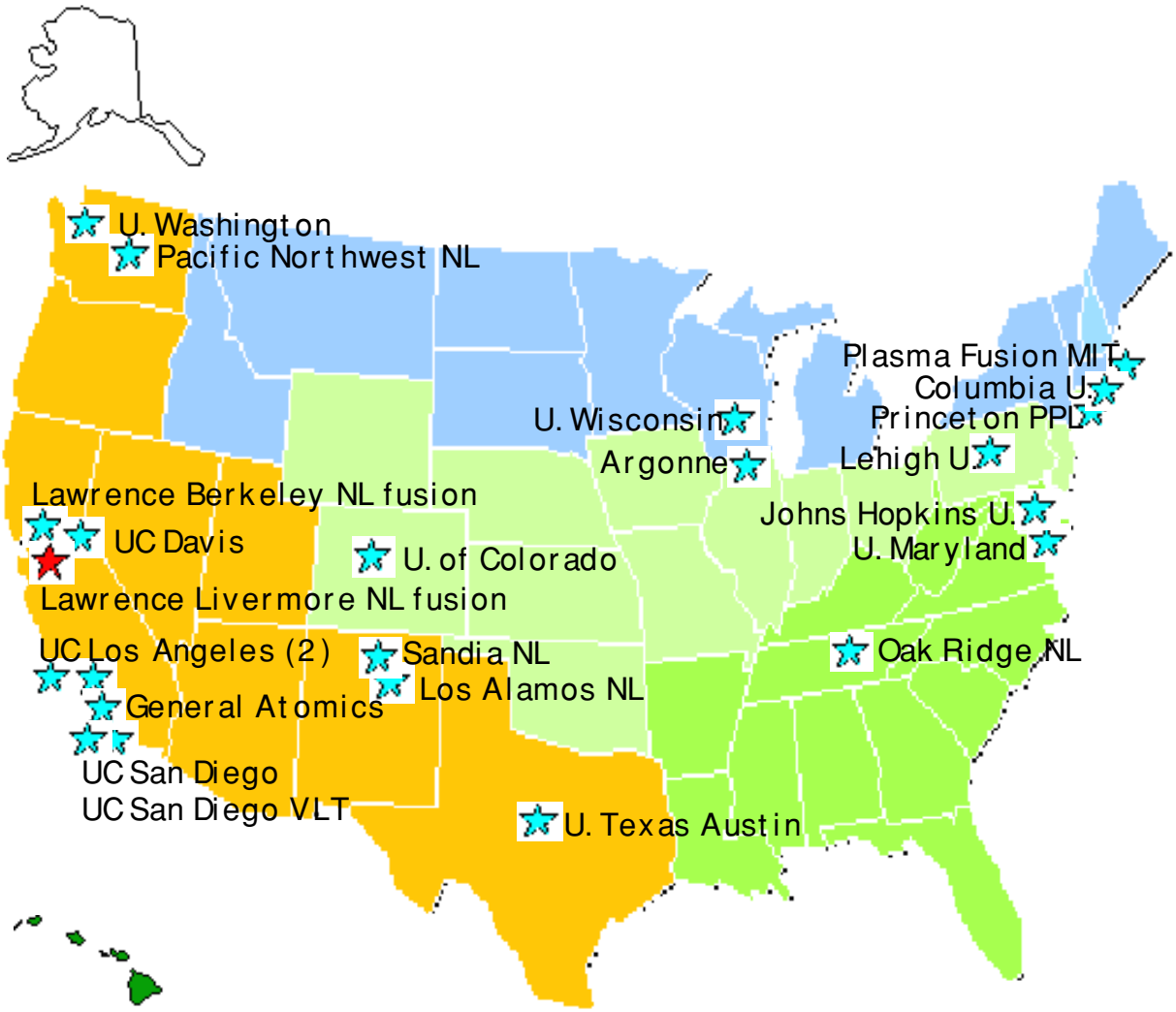

Figure 1. Distribution of ShowStationIP within the US fusion program

This technology has generally been positively received with most groups immediately embracing it due to its nature for enabling remote collaboration meetings. The ShowStationIP has found extensive use at several sites for a variety of meetings such as:

- Weekly Inertial Fusion Energy (IFE) meetings between LLNL, LBNL and PPPL
- Sustained Spheromak Plasma Experiment (SSPX) meetings between LLNL and LANL
- Joint DIII-D meetings with GA, PPPL and LLNL for planning experiments
- Integrated modeling meetings between GA and LLNL
- National Transport Code Collaboration (NTCC) working meetings attended by Lehigh U., TechX Corp, LLNL, U. Texas and GA.
- Weekly broadcast of UCSD Plasma Interactive Surface Component Experimental Station (PISCES) group meetings to PPPL.
- UCSD-PISCES remote participation in NSTX Physics meetings.
- Virtual Laboratory for Technology (VLT) preparation meeting for Fusion Power Associates (FPA) Panel presentation and other preparation meetings
- UCSD-PISCES /PPPL joint presentation to DOE/OFES Program managers on Liquid Li experiments on the Current Drive Experiment Upgrade (CDX-U)
- UCSD-PISCES engineering and design conference meetings with collaborators at PPPL.
- Weekly Alcator C-Mod Staff meetings

- National Spherical Torus Experiment (NSTX) weekly physics meetings.
- NSTX daily run plan broadcast all day from the control room ShowstationIP
- Secure Access working meetings between Tech-X and LLNL.

Many fusion groups have made excellent use of their ShowStationIPs for several different functions and consider it a valuable tool that has saved several trips to other laboratories. Once the staff members at various sites have gotten used to it, there has been little negative feedback from most people involved with its use. The PISCES UCSD fusion group and the Virtual Laboratory for Technology (VLT) have reported "excellent use of the ShowStationIP for several different functions with no negative feedback from the people involved". The NSTX research team has been a strong proponent of this technology as a whole. "People that want the system to work seem to make great use of it". The MFE and IFE groups share hardware at LLNL and both now make regular and routine use to support groups on and off site. The NTCC demonstration software project was one of the first groups to make significant use of this technology. While we have not contacted all the programs for their input, it is clear that in several different segments of the program funded by OFES, the collaboration technologies are having a real effect on our ability to work together in various geographic locations.

There are some limitations to the technology that can affect participants at the local site, and, in some instances, have been cited as a reason for not using it. These limitations are basically the reduced brightness, contrast and image size and resolution in large rooms when compared with standard viewgraph projection systems. The limitations of the technology have minimal effect on work group meetings if the slides are prepared taking the technologies' limitations into account. Smaller conference room applications also minimize the effect of these limitations.

The limitations tend to be more serious for use in a large auditorium where image size and depth of focus pose a bigger concern and have been given as the reason for not using this technology for some meetings. Notable successes for large auditorium use are:
- Planning meeting for Alcator C-mod experiments and scheduled for the NSTX forum in late January 2000.
- MFE/IFE joint seminar series at LLNL.

The MIT/PFSC and PPPL groups have been experimenting with and found some success with connecting the ShowStationIP to projection systems for better viewing locally in a large auditorium. GA used a "dual presentation" to support the DIII-D year end review rather than direct use of the ShowStationIP (laptop computer with a projector for local audience plus a second presenter/facilitator using the ShowStationIP for sending viewgraphs to off-site conference rooms and web browsers). For their experimental forum, GA decided not to use the ShowStationIP in a large conference room but instead revisited the idea of requiring presenters to submit pdf-formatted versions of presentations for web viewing from off site. Roughly 2/3 of the presentations were available for viewing during the meeting.

In addition to the ShowStationIP some of the larger institutions were funded to purchase and install video conferencing systems. Sites at GA, PPPL, LANL, LLNL and MIT have purchased video conferencing systems (Polycom's ViewStation at GA, LANL, LLNL and PPPL and a Tandberg 800 system at MIT). These are "smaller" installations for more routine programmatic use on a "daily basis" rather than the larger institutional facilities that are available at some of these sites. Both PPPL (See S. Davis NSTX design review documentation for full details, http://nstx.pppl.gov/rc_design) and MIT have installed arrays of fixed ceiling microphones attached to Gentner audio processors in their meeting rooms. This equipment allows remote participants to easily hear presentations and audience comments during meetings without burdening the local users with the need to manually distribute and adjust microphones. At LLNL, RF microphones and a mixer is used in combination with the microphone supplied by the video conferencing system.

Sites with large experiments and/or collaborations environments (GA, LLNL, MIT, and PPPL) are also implementing the commercially available Real Networks technology (www.RealNetworks.com) to provide broadcast of audio and video to the Macintosh and PC. LLNL/MFE and PPPL have provided a service of digitally saving presentations upon request to allow re-broadcast at a later time. MIT has also been

extensively using streaming MP3 audio to broadcast the audio from our meetings. Even though this is only one way and audio only, the high quality, short delay times, and freely available software make it very attractive. Audio and video conferencing (interactive participation) and broadcasts (passive viewing without feedback) are synergistic with the previously mentioned ShowStationIP for viewing materials in that they present high quality audio along with video views of the meeting. The combination of A/V conferencing and/or broadcast with the interactive presentation nature of the ShowStationIP provides a powerful remote collaboration capability. We are still experimenting with how best to use the technology and in what types of meetings this technology provides most benefits. Some of the examples of use to date are:

- Broadcast of the DIII-D year-end review – video conferencing + RealNetworks broadcast with the ShowStationIP for off-site viewing and a projector for the local audience.
- Broadcast of the DIII-D brainstorming meeting – video conferencing with limited RealNetworks broadcast. No ShowStationIP but some talks had preloaded pdf files
- Broadcast of the MIT experiment planning forum – video conferencing (RealNetwork not yet in place) with offsite viewing directly from a ShowStationIP that was connected to a projection system for better local viewing.
- IFE/MFE seminar series between LLNL and LBNL which uses IP video conferencing and the ShowStationIP for local and remote viewing. RealNetwork technology is used to reach isolated participants and to digitally save the A/V presentation for later viewing upon request.
- "DIII-D Thrust 7" working meetings for experimental planning among participants at GA, PPPL, and LLNL uses both video conferencing and the ShowStationIP.
- Weekly Alcator C-Mod staff meetings between MIT, PPPL, University of Texas, LANL, etc…
- Levitated Dipole Experiment (LDX) Launcher review between MIT, Columbia, and PPPL
- Alcator C-Mod two dimensional imaging diagnostics review between MIT, PPPL, and LANL
- NSTX weekly physics meetings (Mondays 1:30PM) and monthly project meetings
- NSTX run summary meeting held daily at 5PM.
- NSTX control room audio and video through video conferencing (in auto-answer mode) and the RealPlayer broadcast all day.

While these modern video conferencing systems are generally quite easy to use, there still is some learning process for successful application. Since this technology is new to many of the participants and they are not trained, it does require about 5 to 10 minutes for a new, first time user. However, there has been a rather significant payback in terms of time and funding saved by not requiring additional cross-country travel or even travel between more closely separated sites just to attend a single meeting. Some critical issues do need to be remembered:

- Such remote meetings certainly enhance the ability to collaborate and result in cost savings but do not totally eliminate the need for meetings at the same location. Some topics seem to be best discussed on a more "intimate" and interactive level.
- Each site must take the responsibility to install the equipment and make it operational. It is best if permanent locations are configured to avoid recurrent setup time and/or confusion as to the availability of the hardware.
- Each site must develop some expertise in its use and make that expertise available to the researchers. In time, we should all become familiar with its operation and the support should become minimal.

An important lesson that has been learned is that, while it is easier to set up for a large meeting such as a an experimental planning forum or program review, interested participants tend to prefer to be on site for these sort of meetings if at all possible. Smaller workgroup meetings and discussion sessions among widely dispersed collaborators seem to be very well served by the technology available. These meetings tend to be much more frequent and use of collaboration technologies could result in a substantial reduction in travel costs and, more importantly, in a significant increase in participation. However, they require a more widespread knowledge of how to use the technology (a learning curve issue) and have met with some resistance by researchers worried about "property rights" when new, unpublished ideas are to be presented.

The sociological aspects of making new information readily available to off-site collaborators, even when access controls are in place, have not yet been fully resolved. Sites have reported some individual cases where researchers are either reluctant or refuse to use the technology due to "privacy concerns". While there are instances where meetings should remain "private", many of us feel that those meetings critical to the success of physics collaboration efforts should be made available to remote participants via this technology which does support fairly standard authentication mechanisms. The experience at LLNL (where the technology was in place prior to the DoE funding) is that once users become familiar with it, its availability will become a requirement. Even telephone conference calls supplemented by the ShowStationIP offer a significant enhancement for remote discussions. Almost any combination of the technologies discussed; video conferencing, audio/video broadcast, ShowStationIP, and conference calls, increases the information flow and directly enhances the ability for off-site researchers to participate.

Remote access to experiments

Funding was provided to take the next step in providing remote access to the large experiments, DIII-D, Alcator C-mod and NSTX. A significant prior effort in this area was undertaken at the DIII-D National Facility (by LLNL, GA, PPPL and ORNL under the Distributed Collaborative Experimental Environments (DCEE funding in 1996/97) to demonstrate the utility of remote access to the site from off-site participants. This capability is routinely used by researchers at LLNL. The current effort is intended to improve on those initial efforts, use commercially available software and provide this type of access to the three large experiments. Examples in place today are:

- NSTX multipoint video-conferencing and conference call technology provides interactive connections to the control room (see http://nstx.pppl.gov/rc_design)
- Alcator C-mod has improved and generalized their video/audio connection to the control room using the RealNetworks technology.
- DIII-D has replaced the MBONE technology previously used for audio/video in the control room with the RealNetworks technology.

With the experiments in operation and some now starting up again, we are gaining more experience with the use of the technology recently put in place. Live video, audio, and plasma video (emission during a shot) from the Alcator C-Mod experiment is regularly available to offsite collaborators in Texas and LANL during experiment operations. This can be accessed at http://www.psfc.mit.edu/cmod/control_room_rv1.html. The NSTX control-room audio and video and daily run status meeting is regularly broadcast using Real Player technology. The status of the NSTX experiment is kept up to date and available to remote collaborators on a ShowStationIP installed in the control room. While not funded under this initial effort, the SSPX experiment is currently using free versions (low resolution video) of the RealServer and the RealEncoder running on existing SGI platforms to provide live video from the SSPX vessel area during operations. Offsite collaborators at LANL and the Himeji Institute of Technology, Japan can access the video and a JavaChat application (developed for DIII-D) for communication with LLNL during experiments.

In this current implementation, we have moved from the "free", developmental solutions to the more robust, commercially available technologies, which often favor the use of web browsers at the desktop. We have moved from the initial MBONE IP-based technology to the use of RealNetwork technology. MBONE, while free and bi-directional in nature, was difficult to support at many sites, often negatively viewed by network administrators, and did not adequately support the growing demand for PCs and Macintosh computers. The RealNetwork technology, while better supported for PC and Macintosh platforms, is not as well supported on UNIX workstations and is broadcast only, e.g. unidirectional and therefore not supporting "talk back" from remote locations. NSTX has adopted the use of video conferencing and conference call technology to get around this deficiency.

Authenticated access to facilities and data is becoming a more critical issue. Firewalls, virtual private networks (VPNs) and IP port access control software is being installed to address the cyber security upgrades at most major laboratories. The NSTX engineering network is protected by a tightly configured

firewall that allows for great versatility in allowing access to the NSTX control systems. The system can be configured to allow remote collaborators to participate both in control system development and operation. Although they have not ventured into the remote operations arena yet, this capability could be easily exercised. The firewall allows for a variety of connection schemes from VPN, to encrypted authentication, to simple secure encrypted connections direct to nodes on the secure engineering network. Of course, by design the network does not provide access to any systems that are responsible for equipment or personnel protection. Currently the firewall is configured to allow restricted sets of data and control and monitoring information to flow between the secure engineering network and the PPPL open networks.

Software infrastructure to advance collaborations.

Three areas were funded: MDSplus Development, Security Concepts, and Object Database Evaluation. The Database Evaluation effort will be described in a later paper.

* Security concepts.

A collaboration between Tech-X Corp and LLNL was funded to explore issues surrounding security associated with the use of object technologies communicating over wide area networks using the CORBA communications standard and web server applications. Potential applications are in remote, wide area networks for distributed code execution (e.g. Java, Python and NTCC demonstration), read/write data access and experiment control. Given the current environment of cyber security upgrades, the issue of secure access to computing services is becoming critical. Previous to this funding, LLNL employed the DCE security services (Kerberos) in demonstration applications between LLNL and GA. The current approach to remote, distributed computing applications has shifted to the object oriented technologies using the CORBA communications standard. This, along with secure web-based applications, has become the focus of these more recent security investigations. The effort to date includes a preliminary study of the technologies associated with authentication mechanisms applicable to both CORBA and web servers.

Studies were made of the details of the RSARef and OpenSSL software for making encrypted connections over the network. OpenSSL is a commercial grade, full featured, open source toolkit for implementing the Secure Socket Layers (SSL v2/v3) protocols with full-strength cryptography worldwide. RSARef is a library of cryptographic utilities that was released by RSA Laboratories and is used by OpenSSL. This software was chosen because it is basically free for commercial and non-commercial use.

The use of the OpensSSL software was explored to generate authentication mechanisms needed for secure applications. Digital Signature Algorithms (DSA) were used to generate DSA certificates and thus make project participants certifying authorities (CA) able to generate certificates and public and private keys. We determined how to make certificate requests and then sign these requests as the CA. Test scripts to perform these tasks were generated and stored with instructions for these tasks documented at https://skibuff.llnl.gov/wwwofesnet/build_docs/DSAGen.html. An issue with DSA is the lack for its support in the main browsers, Netscape and Internet Explorer. The RSA algorithms are supported. Hence, the use of OpenSSL with RSA algorithms was investigated for becoming certifying authorities. We further were able to use the OpenSSL software with RSA encryption (for testing purposes only, given the patent restrictions) to sign applets that would run in the popular browsers. We have thus been able to solve the problem of secure distribution of client software. Furthermore, with the ability to be certifying authorities, we have solved the problem of authentication of off-site users to on-site users and vice-versa.

An effort was started to determine how to incorporate authentication algorithms into the object communication model, CORBA. We are planning to use CORBA on top of the secure socket layer. To facilitate this we acquired developer licenses for Orbacus and iSaSiLk. Orbacus provides the CORBA Orb in C++ and Java and iSaSiLk provides the SSL implemented as a set of Java classes required by the Java Orbacus package. We were able to build the Java SSL classes and communicate securely with the OpenSSL and our secure webserver. Also, we have investigated the use of the MICO ORB. MICO is a free C++ implementation of CORBA. MICO is able to make connections over SSL. Thus, with MICO one can put CORBA servers at separated sites connected by the Internet but with secure communication using SSL.

At each end, where the networks are protected by firewalls, one can then connect through insecure protocols to legacy servers. One can run Java clients over insecure protocols (through free Java-CORBA implementations) to the client end MICO server without compromising security.

In the remainder of the year a system with CORBA ORB's will be implemented. It will operate behind firewalls at two sites, communicating over SSL using the MICO implementation. The system will demonstrate authentication and authorization, ultimately providing secure access to MDS plus through the NTCC data server. At the client site, the ORB will read data from an SSL client, but provide it through non-SSL sockets, thus making it available through existing NTCC Java clients. We will also develop a demonstration client library for securely importing data into other analysis codes, such as the combined CORSICA/ONETWO code and the NTCC demonstration code, from remote datastores.

* MDSplus

The MDSplus software collaboration has continued to thrive. During the past year major strides were achieved on the port from VMS to UNIX platforms and to Windows/NT. Progress has been made on the documentation project. The system is now being used at MIT, GA, PPPL, EPFL, IGI, ANU, University of Washington. NSTX has been operating doing both data acquisition and analysis using MDSplus. DIIID is storing processed data into MDSplus trees as part of their day to day operations. Installations are planned for Columbia University and the CHS experiment at NIFS. University of Wisconsin, UCSD and UCLA are negotiating installations.

For the cross platform port, the remaining features of the system are now being ported to non VMS-platforms. Initial implementations of event notification and task dispatching have been done and there are plans for UNIX based device I/O support. Once this is complete, it will be possible to run an end to end data automated end to end data acquisition and analysis system using MDSplus on a UNIX platform.

In the data analysis support, work on interfacing physics modeling and analysis codes to MDSplus for both input and output is proceeding. The MDSplus implementations of EFIT in use at GA and MIT are being combined into a single version that can be used by the entire community. Other codes that are being integrated into this environment are TRANSP, DCON, PEST, and MIST.

A generalized code run management database is being developed. This database will be used to keep track of the runs of various analysis and modeling codes. The schema modeled on the TRANSP run database at MIT is complete and a set of test records is being loaded so that work on the user interface can begin. When this is complete it will be very simple to integrate run management into the operation of any physics modeling code.

The MDSplus team has worked closely with the NTCC to provide an MDSplus data interface to their project. Since data at the three major US facilities, GA, PPPL, and MIT, are stored in this format, this provides the project access to data from a wide variety of sources. Since MDSplus can be used as both a network access method and as a gateway to other data systems, this could be used by NTCC to access virtually any data set.

The relational database interface between IDL and SQLServer, while not strictly part of MDSplus, is being used at almost all of the MDSplus sites. It provides simple access to data stored in a relational database to both application designers and the user community. Over the past year it has been ported to additional flavors of UNIX and to Windows based architectures. The entry_display Logbook application, which is layered on top of this, is currently in use at MIT, GA, PPPL, and EPFL. Work is proceeding on WEB based version.

As the use of MDSplus spreads, the need for more comprehensive documentation is growing. To address this, a documentation project for the system has begun. A complete outline of the documentation is

complete and many of the sections are filled in. All of this material is available on the web at: http://www.psfc.mit.edu/MDSplusDOC/.

This initiative has allowed MDSplus developers to travel to attend technical workshops, present papers, visit MDSplus sites, and meet with code developers. Some of this travel is listed below:

- NTCC meeting at Lehigh
- 2nd IAEA Technical Committee Meeting on Control, Data Acquisition and Remote Participation on Fusion Research Lisbon, Portugal
- EPFL technical visit to install relational database and logbook software
- MDSplus developers meeting at GA